# The Shorekeepers' Guide to Monitoring Marine Intertidal Habitats

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## Abstract

With increasing interest in marine conservation and marine protected areas by the general public and special interest groups, there is a growing demand on resource management and environmental science agencies to actively solicit and incorporate citizen involvement in both habitat assessment and long-term monitoring of marine resources. Intertidal ecosystem impacts typically relate to loss of habitat through infilling, substrate or beach slope alteration; increased sedimentation; alteration of freshwater discharges across the intertidal; biological changes resulting from trampling, removals or exotics; and introduction of chemical pollutants or physical structures. Point specific impacts are most amenable to management action.

Currently on Canada's West Coast, the challenge is to document intertidal impacts by technical training and coordination of community groups. Groups would be given defensible but practical methods to allow determination of whether or not indigenous marine ecosystems, and specifically their non-exploited renewable resources, are in fact being sustained. To meet the objective of obtaining detailed coastal resource information from trained non-professionals, Pacific Region researchers of Fisheries and Oceans Canada have developed and tested a sampling and training protocol published as the "Shorekeepers' Guide" for surveying intertidal habitats and associated biota in British Columbia. The overall goal is to produce data of sufficient quantity and quality for use by habitat managers, ocean planners and science researchers who are monitoring and assessing changes in marine communities. Here, we briefly describe the Guide's mapping and surveying protocols and give an initial evaluation of data collected over the past five years, largely from Vancouver Island. We also discuss issues of field surveying, recruit training and data management that influence the reliability and utility of data provided by this protocol and others like it. The merits of biological decision-making frameworks such as the Index of Biotic Integrity that could use such citizen science data are explored in light of the nature of management authority currently given to marine resource managers.

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Although intertidal biological studies have been conducted along British Columbia's coasts for decades, few credible biological community time-series of data exist. Studies to date have been typically of relatively short duration (<4 years), seldom repeated at the same location, often biased for certain species or habitats, and often utilised a sampling protocol having a limited objective.

Because of microhabitat complexity and spatial and temporal variability in species' settlement patterns, monitoring species' abundance in habitats in a credible, quantitative manner is not a trivial task. It is difficult for lay people, who often have difficulty in even identifying species, to provide useful, credible data unless they are both properly trained and guided. The Shorekeepers' Guide (Jamieson et al. 1999) is a comprehensive protocol developed for this purpose by Fisheries and Oceans Canada.

The approach adopted in the Guide is as follows: volunteer youth and adults from non-governmental organisations, high schools, First Nations and community groups conduct surveys under the direction of a biologist, or trained leader; and a training curriculum and certification approach is provided to ensure that leadership training is of acceptable quality and standardised. We have found that for 50 to 100 m of shoreline length, an optimal team size per site is 6 to 8 people, including the leader, to allow a survey to be conducted in one tidal cycle. A study site is characterised as a group of different habitat patches, each greater than 25 m², from the high water mark to as low as the tide goes during the study period. The dimensions of each habitat are measured and mapped.

**Figure 1:** Quadrate sampling in a cobble habitat using the Shorekeepers' Guide protocol.

Training is provided for species' identification, enumeration techniques, habitat and substrate recognition, habitat mapping, slope and elevation measuring, data recording, beach safety and etiquette. Individuals are familiarized with required tasks before the survey, and are each assigned designated responsibilities in the survey. Post-sampling data recording and data submission to Fisheries and Oceans Canada is the responsibility of the leader.

Habitat types are defined by both substrate and biological communities present (e.g. eelgrass bed, mudflat, macroalgae patch, bedrock, etc.), and a map of the site showing habitat boundaries is sketched from a fixed baseline and tape-measurements, and included as part of the dataset. Habitat patches are divided horizontally and vertically by two to four equidistant lines, with samples taken at each line intersection, i.e. 6 to 12 samples per habitat unit, depending on time availability. Sampling areas are 25x25 cm for soft substrates to a depth of 10 cm and 50x50 cm for hard substrates (Figure 1). All macro-organisms present are identified and counted, or abundance estimated if the species is particularly numerous.

After about five years of sampling for protocol development. We initiated a protocol evaluation and data assessment exercise (Jamieson et al. 2002), with results summarised here. This "audit project" of sampling, mapping and data handling procedures was initiated in 2001/2002 as part of an ongoing review. Objectives included:
- Assessing the quality of data collected to date.
- Identifying problems encountered in data acquisition.
- Recommending improvements of field protocols, data handling and leader training.

Caveats associated with this review are that:
1. Protocols were still under development as data were acquired, and minor changes were made in the data time series as experience was gained. Consequently, there were proportionally more errors in early survey efforts.
2. Survey funding was from different sources, and so each year's surveys typically involved new participants (e.g. displaced fishers) with varying motivation or skills.
3. Leader training also improved over time, introducing fewer data errors over time.

## Recommended Improvements
From our review, the following issues were identified:
A. Adherence to described procedures:
- Better definition of habitat types to minimise likelihood of habitat mislabelling.
- Greater emphasis on the need to define appropriate site location benchmarks, so that comparable surveys can be repeated in subsequent years.
- Improved verification of scales and measurements recorded on sketch maps needed, to ensure confidence in the calculated areas.

B. Identification of plants and animals:
- The leaders' capabilities to identify local species needs to be regularly assessed, and improved when necessary. Maintenance of reference collections should also be stressed. The better the quality of training, the better the results likely to be obtained.
- Or, if funding or expertise limited, a limited list of species might be considered, depending on the survey objectives in effect. However, consideration of only a specified suite of species may fail to document important ecosystem changes involving other species. Effective monitoring of ecosystem diversity requires a capability to identify and monitor most species.
- Improved taxonomic expertise is likely difficult to attain, since training resources, useful taxonomic keys and accessible experts may be unavailable.

C. Transcription errors:
- Transcription error rate of information between field sheets and computer spreadsheets was low when the information was simply entered electronically.
- Errors were more common when the information was treated mathematically (.e.g., calculation of habitat areas by hand) before entering it into spreadsheets.
- To eliminate or minimise transcription errors in the future, a designated full-time data technician should be assigned to verify data and to manipulate them appropriately.

D. Field audits:
- Audit teams should consist of well trained staff.
- Several sites should be audited to obtain a comparison of team performances for different habitat types.
- Each site should be audited shortly after the original survey, preferably during the same low tide cycle.
- Only one team should do all the audits.

E. Survey Design:
- The overall issue is whether to sample abundances of species in quadrats or simply to emphasis habitat mapping, possibly over a larger area than the 50 to 100 m area shore length presently specified. This is likely to always be an issue until a specific goal for a survey is identified (surveys to date were not goal focused, as it was the survey approach itself that was being developed), at which time the merits of contrasting approaches can be specifically applied.
- Most data variation is attributable to quadrat-quadrat differences even when selected from the same area, year, habitat type, and habitat location. However, when considering all species, the minimum and maximum values of the decomposition analysis indicated that while most species follow this general pattern, there is considerable variation in how their variation is partitioned.
- This data variation pattern implies that the gain from permanent monitoring sites would not be expected to be large. Opportunistic sampling is choosing similar sites, and there appears to be only small changes over time.

F. Data collection:
- The number of quadrats entered into the database was sometimes less than the number nominally surveyed. It's now not certain whether they were not surveyed (e.g. lack of time) or whether no organisms of any species were observed, and so no entries were made for that quadrat.
- At the species level, the database did not have a mechanism for entering a count of zero for a species in order to distinguish between "data missing" or "species not counted." Most statistical packages will not automatically impute a value of zero when a record is absent. Consequently, the mean density computed could be based on non-zero counts only. The database is now being redesigned so that zero counts are explicitly included when species are absent. Zeros will be included with the raw data, or data extraction programs will insert zeros when exports are produced.
- Counts of some species in a quadrat were very high. These are unlikely to be actual counts and are likely estimates of abundance. This makes specific quantitative analysis for these species problematic, as a few large counts have an extreme influence on means and standard deviations. Particularly abundant species perhaps should be simply estimated and coded as "very abundant", rather than attempting accurate counts.

G. Data Analyses:
- Derived variables should not be stored in the database as it may be difficult to enforce consistency if changes and updates are later made to the base values, e.g. density estimates for an earlier year might not be automatically updated if a count value is later changed?

- The relatively large variations observed, implies that consideration of auto-correlation over time or space may be moot, and in many cases can be "ignored" without compromising the results.
- Comparisons of species compositions among habitat units are not informative and may simply reflect habitat effects. Analyses should be confined to within a particular habitat unit.
- Another analysis technique of species composition that might be considered in analyses is the ratio of two species (e.g. types of crabs) within quadrats; achieved after suitable transformation using ANOVA methods.

## Conclusions

To date, Shorekeepers has focused on developing methods and evaluating results, rather than an assessment of "ocean health" *per se*. Many sites chosen to date were more for ease of access rather than their utility in addressing specific ocean management issues. Future site selections should now focus on the latter, with clear identification of both "control" and "impacted" areas, with appropriate replication of both. Analyses for a BACI (Before After/Control Impact) design are quite different than an analysis to find a trend over time based on sites selected for general survey work.

With large "noise" in the data, it may be difficult to detect changes over short time periods. Extended data collection over a number of years should be planned and coordinated. While consistency in sampling the same number of quadrats in all habitats of the same type in all survey years may be nice, there is no statistical requirement for uniform sampling over time. Based on a long time series, it may become desirable that sampling effort increases over time for certain habitat types, particularly if the variability observed is unacceptably high with limited samplings. Power analysis to determine how many additional years or study areas are required to detect a difference might be utilised. However, it must be remembered that Shorekeepers' surveys are not an academic project. We simply don't know when, or even if, significant ecosystem differences or changes will occur. Shorekeepers' program might thus need to monitor for potential intertidal site changes almost yearly, regardless of any 'academic' power analysis recommendations.

The merit of changing the focus from organism-based habitats (e.g. Ulva, Fucus, Other Algae) to permanently marked habitats, regardless of which structural species occur there; and the merits of reducing the number of species sampled, focusing on those that are easier to identify, and revising the Shorekeepers' Guide to assist in field identifications, is being considered. However, until specific ocean management issues are identified for study, it is difficult to address this issue in a practical sense.

The issues identified in the above were primarily focused around the maintenance of data quality and improvements in data analysis. There has been no addressing of the overall utility of Shorekeepers' data for use by resource managers, coastal planners and others. The end use of these data will significantly influence the dates and locations sampled, and perhaps the choice of relevant metrics (e.g. Index of Biotic Integrity (Karr and Chu 1999)) to evaluate the "health" of regional intertidal ecosystems. Preliminary data are typically needed to analyse how data might best be used and what data specifically should be collected—this has been the emphasis to date. Preliminary analysis has begun, but it will take a number of years to complete. This will involve the incorporation of other information such as the biological tolerances of the different species observed to different environmental conditions, and what guilds of species are most representative of "pristine" conditions.

Nevertheless, from data collected to date, we can now begin to assess the merits of decision-making frameworks and discuss with resource managers the types of management decisions they are capable of making. Intertidal ecosystem impacts typically relate to habitat loss through infilling, substrate change or beach slope alteration; increased sedimentation; alteration in freshwater discharges across the intertidal; biological change from trampling, removals or exotics; and introduction of pollutants or toxins. Point specific impacts are most amenable to management action, while the causes of others may be more difficult to ascertain and consequently be addressed by managers.

# References

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